

AD A950784

BADGER ARMY AMMUNITION PLANT  
OLIN CORPORATION  
ENERGY SYSTEMS DIVISION  
BARABOO, WISCONSIN

D T I C  
ELECTRIC  
S J U L 2 4 1981

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DESIGN COMPARISON OF CONTINUOUS NITRATORS

biazzini  
Hanspeter Moser  
Nitro Nobel

Basis: A Continuous Facility of 1,600 PPH of Nitroglycerin

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	<u>Biaazzi</u>	<u>Hanspeter Mosser</u>	<u>Nitro Nobel</u>
<b>A. Nitrator</b>			
1. Nitrator Type	Stirred Reactor Vessel	Stirred Reactor Vessel	Injector Mixing Tee
2. Nitrator Capacity	30 Gallons	20 Gallons	½ Gallon
3. Nitrator Power	15 hp Electric Motor	20 hp Hydraulic Drive Turbine	None
4. Nitrator RPM	540 rpm (Exits at 5 ft/sec)	~ 600 rpm	2.6 ft/sec Out of Tee
5. Nitration Temperature	16° C.	20° C.	47° C.
6. Nitrator Cooling	5 Spiral Brine Coils in Nitrator	Vertical Hairpin Brine Coils in Nitrator	50 Gallon Spiral Cooler Located Below Tee
7. Retention Time in Nitrator	6 Minutes	~ 4 Minutes	3 Seconds
8. Retention Time in Cooler	-	-	3 Minutes
9. NG Content at Any One Time	160 Pounds	~ 130 Pounds	~ 60 Pounds
10. Cooling Surface	150 ft <sup>2</sup>	~ 100 ft <sup>2</sup>	160 ft <sup>2</sup> in Spiral Cooler
11. Drowning Time	15 Seconds	5 Seconds	3 Minutes
<b>B. Control of Nitrator</b>			
1. Mixed Acid Feed Method	Volumetric gear pump from shift feed tank.	Volumetric pump from shift feed tank.	Pumped through control valve and flowmeter.
2. Adjustment of Acid Feed	Variator on pump motor with flowmeter indicator.	Variable gear system with magnetic flowmeter.	Control valve.
3. Glycerin Feed Method	Same as acid.	Same as acid.	Sucked from feed tank by injector.
4. Adjustment of Feed	Variator between glycerin pump and acid pump with flowmeter indicator.	Second gear system connected to acid pump gear system and pumped through flowmeter.	Controlled by rate acid goes through injector and goes through control valve and meter.

	<u>Biazz</u>	<u>Hanspeter Moser</u>	<u>Nitro Nobel</u>
5. Control of Reaction Temperature	3-way valve on brine line.	Control valve on brine line.	Controlling glycerin flow.
C. <u>Separator</u>			
1. Separator Type	Semi-Static Separator	Static Separator	Centrifugal Separator DeLaval NGB-209-17B
2. Maximum Diameter	60 Inches	60 Inches	18 Inches
3. Capacity	210 Gallons	100 Gallons	800 Gallons
4. NG Retention Time	8 Minutes	4 Minutes	1 Minute
5. Acid Retention Time	50 Minutes	30 Minutes	30 Minutes
6. Total Amount of NG	170 Pounds	100 Pounds	50 Pounds
7. Amount of Free NG	40 Pounds	45 Pounds	10 Pounds
8. Drowning Time	12 Seconds	5 Seconds	6 Minutes
9. Power Requirement	None	None	4 hp
10. Separator Peripheral Speed	- 20 rpm	- 30 rpm	3,200 rpm
11. Separation Control	Interface control by controlling spent acid leaving.	Interface control by controlling spent acid leaving.	By controlling flow input to ejector that jets NG to next step.
D. <u>Spent Acid Diluter</u>	30 gal stirred cooled vessel where water is added.	40 gal stirred cooled vessel where water is added.	None Adaptable for water addition.
E. <u>Washing and Neutralizing</u>	Countercurrent flow of emulsified NG through 3 mechanical stirred vessels of soda water.	Flow through an up and down column of soda water, separated, then through another column of water washing and finally separated.	Flow through a 16 gal degassing vessel up through 2 soda wash columns into a separator to remove soda water.
1. <u>Washing Method</u>			

BiaazziHanspeter MoserNitro Nobel

2. Diameter 20 Inches

3. Total Capacity 80 Gallons

4. Number of Washes 3

5. Total Retention Time 9 Minutes

6. Stirring RPM 600 rpm

7. Power Required 2 hp/washer

8. Total Amount of NG Present 100 Pounds

9. Soda Water Concentration 12%

10. Control pH meter in last washer.

11. Cooling Area 9 ft<sup>2</sup> in first washer.

12. Emulsion Separators Capacity

F. Utility Requirements

1. Electrical (hp) 4

2. Compressed Air (cfm) 40

3. Air Pressure (psi) 60

4. Refrigeration (tons) 33

5. Process Water (gpm) 7

6. Process Steam None

11. Cooling Area 9 ft<sup>2</sup> in first washer.

12. Emulsion Separators Capacity

13. Air Pressure (psi) 100

14. Refrigeration (tons) 100

15. Process Water (gpm) 30

16. Process Steam None

17. Total Capacity 140 Gallons

18. Air Pressure (psi) 80

19. Refrigeration (tons) 50

20. Process Water (gpm) 31

21. Process Steam 13

22. Total Capacity 300 Pounds

23. Air Pressure (psi) 10%

24. Refrigeration (tons) 10%

25. Process Water (gpm) 8%

26. Process Steam

27. Total Capacity 300 Pounds

28. Air Pressure (psi) 8%

29. Refrigeration (tons) 10%

30. Process Water (gpm) 8%

31. Process Steam

32. Total Capacity 300 Pounds

33. Air Pressure (psi) 8%

34. Refrigeration (tons) 8%

35. Process Water (gpm) 8%

36. Process Steam

37. Total Capacity 300 Pounds

38. Air Pressure (psi) 8%

39. Refrigeration (tons) 8%

40. Process Water (gpm) 8%

41. Process Steam

42. Total Capacity 300 Pounds

43. Air Pressure (psi) 8%

44. Refrigeration (tons) 8%

45. Process Water (gpm) 8%

46. Process Steam

47. Total Capacity 300 Pounds

48. Air Pressure (psi) 8%

49. Refrigeration (tons) 8%

50. Process Water (gpm) 8%

51. Process Steam

52. Total Capacity 300 Pounds

53. Air Pressure (psi) 8%

54. Refrigeration (tons) 8%

55. Process Water (gpm) 8%

56. Process Steam

57. Total Capacity 300 Pounds

58. Air Pressure (psi) 8%

59. Refrigeration (tons) 8%

60. Process Water (gpm) 8%

61. Process Steam

62. Total Capacity 300 Pounds

63. Air Pressure (psi) 8%

64. Refrigeration (tons) 8%

65. Process Water (gpm) 8%

66. Process Steam

67. Total Capacity 300 Pounds

68. Air Pressure (psi) 8%

69. Refrigeration (tons) 8%

70. Process Water (gpm) 8%

71. Process Steam

72. Total Capacity 300 Pounds

73. Air Pressure (psi) 8%

74. Refrigeration (tons) 8%

75. Process Water (gpm) 8%

76. Process Steam

77. Total Capacity 300 Pounds

78. Air Pressure (psi) 8%

79. Refrigeration (tons) 8%

80. Process Water (gpm) 8%

81. Process Steam

82. Total Capacity 300 Pounds

83. Air Pressure (psi) 8%

84. Refrigeration (tons) 8%

85. Process Water (gpm) 8%

86. Process Steam

87. Total Capacity 300 Pounds

88. Air Pressure (psi) 8%

89. Refrigeration (tons) 8%

90. Process Water (gpm) 8%

91. Process Steam

92. Total Capacity 300 Pounds

93. Air Pressure (psi) 8%

94. Refrigeration (tons) 8%

95. Process Water (gpm) 8%

96. Process Steam

97. Total Capacity 300 Pounds

98. Air Pressure (psi) 8%

99. Refrigeration (tons) 8%

100. Process Water (gpm) 8%

101. Process Steam

102. Total Capacity 300 Pounds

103. Air Pressure (psi) 8%

104. Refrigeration (tons) 8%

105. Process Water (gpm) 8%

106. Process Steam

107. Total Capacity 300 Pounds

108. Air Pressure (psi) 8%

109. Refrigeration (tons) 8%

110. Process Water (gpm) 8%

111. Process Steam

112. Total Capacity 300 Pounds

113. Air Pressure (psi) 8%

114. Refrigeration (tons) 8%

115. Process Water (gpm) 8%

116. Process Steam

117. Total Capacity 300 Pounds

118. Air Pressure (psi) 8%

119. Refrigeration (tons) 8%

120. Process Water (gpm) 8%

121. Process Steam

122. Total Capacity 300 Pounds

123. Air Pressure (psi) 8%

124. Refrigeration (tons) 8%

125. Process Water (gpm) 8%

126. Process Steam

127. Total Capacity 300 Pounds

128. Air Pressure (psi) 8%

129. Refrigeration (tons) 8%

130. Process Water (gpm) 8%

131. Process Steam

132. Total Capacity 300 Pounds

133. Air Pressure (psi) 8%

134. Refrigeration (tons) 8%

135. Process Water (gpm) 8%

136. Process Steam

137. Total Capacity 300 Pounds

138. Air Pressure (psi) 8%

139. Refrigeration (tons) 8%

140. Process Water (gpm) 8%

141. Process Steam

142. Total Capacity 300 Pounds

143. Air Pressure (psi) 8%

144. Refrigeration (tons) 8%

145. Process Water (gpm) 8%

146. Process Steam

147. Total Capacity 300 Pounds

148. Air Pressure (psi) 8%

149. Refrigeration (tons) 8%

150. Process Water (gpm) 8%

151. Process Steam

152. Total Capacity 300 Pounds

153. Air Pressure (psi) 8%

154. Refrigeration (tons) 8%

155. Process Water (gpm) 8%

156. Process Steam

157. Total Capacity 300 Pounds

158. Air Pressure (psi) 8%

159. Refrigeration (tons) 8%

160. Process Water (gpm) 8%

161. Process Steam

162. Total Capacity 300 Pounds

163. Air Pressure (psi) 8%

164. Refrigeration (tons) 8%

165. Process Water (gpm) 8%

166. Process Steam

167. Total Capacity 300 Pounds

168. Air Pressure (psi) 8%

169. Refrigeration (tons) 8%

170. Process Water (gpm) 8%

171. Process Steam

172. Total Capacity 300 Pounds

173. Air Pressure (psi) 8%

174. Refrigeration (tons) 8%

175. Process Water (gpm) 8%

176. Process Steam

177. Total Capacity 300 Pounds

178. Air Pressure (psi) 8%

179. Refrigeration (tons) 8%

180. Process Water (gpm) 8%

181. Process Steam

182. Total Capacity 300 Pounds

183. Air Pressure (psi) 8%

184. Refrigeration (tons) 8%

185. Process Water (gpm) 8%

186. Process Steam

187. Total Capacity 300 Pounds

188. Air Pressure (psi) 8%

189. Refrigeration (tons) 8%

190. Process Water (gpm) 8%

191. Process Steam

192. Total Capacity 300 Pounds

193. Air Pressure (psi) 8%

194. Refrigeration (tons) 8%

195. Process Water (gpm) 8%

196. Process Steam

197. Total Capacity 300 Pounds

198. Air Pressure (psi) 8%

199. Refrigeration (tons) 8%

200. Process Water (gpm) 8%

201. Process Steam

202. Total Capacity 300 Pounds

203. Air Pressure (psi) 8%

204. Refrigeration (tons) 8%

205. Process Water (gpm) 8%

206. Process Steam

207. Total Capacity 300 Pounds

208. Air Pressure (psi) 8%

209. Refrigeration (tons) 8%

210. Process Water (gpm) 8%

211. Process Steam

212. Total Capacity 300 Pounds

213. Air Pressure (psi) 8%

214. Refrigeration (tons) 8%

215. Process Water (gpm) 8%

216. Process Steam

217. Total Capacity 300 Pounds

218. Air Pressure (psi) 8%

219. Refrigeration (tons) 8%

220. Process Water (gpm) 8%

221. Process Steam

222. Total Capacity 300 Pounds

223. Air Pressure (psi) 8%

224. Refrigeration (tons) 8%

225. Process Water (gpm) 8%

226. Process Steam

227. Total Capacity 300 Pounds

228. Air Pressure (psi) 8%

229. Refrigeration (tons) 8%

230. Process Water (gpm) 8%

231. Process Steam

232. Total Capacity 300 Pounds

233. Air Pressure (psi) 8%

234. Refrigeration (tons) 8%

235. Process Water (gpm) 8%

236. Process Steam

237. Total Capacity 300 Pounds

238. Air Pressure (psi) 8%

239. Refrigeration (tons) 8%

240. Process Water (gpm) 8%

241. Process Steam

242. Total Capacity 300 Pounds

243. Air Pressure (psi) 8%

244. Refrigeration (tons) 8%

245. Process Water (gpm) 8%

246. Process Steam

247. Total Capacity 300 Pounds

248. Air Pressure (psi) 8%

249. Refrigeration (tons) 8%

250. Process Water (gpm) 8%

251. Process Steam

252. Total Capacity 300 Pounds

253. Air Pressure (psi) 8%

254. Refrigeration (tons) 8%

255. Process Water (gpm) 8%

256. Process Steam

257. Total Capacity 300 Pounds

258. Air Pressure (psi) 8%

259. Refrigeration (tons) 8%

260. Process Water (gpm) 8%

261. Process Steam

262. Total Capacity 300 Pounds

263. Air Pressure (psi) 8%

264. Refrigeration (tons) 8%

265. Process Water (gpm) 8%

266. Process Steam

267. Total Capacity 300 Pounds

268. Air Pressure (psi) 8%

269. Refrigeration (tons) 8%

270. Process Water (gpm) 8%

271. Process Steam

272. Total Capacity 300 Pounds

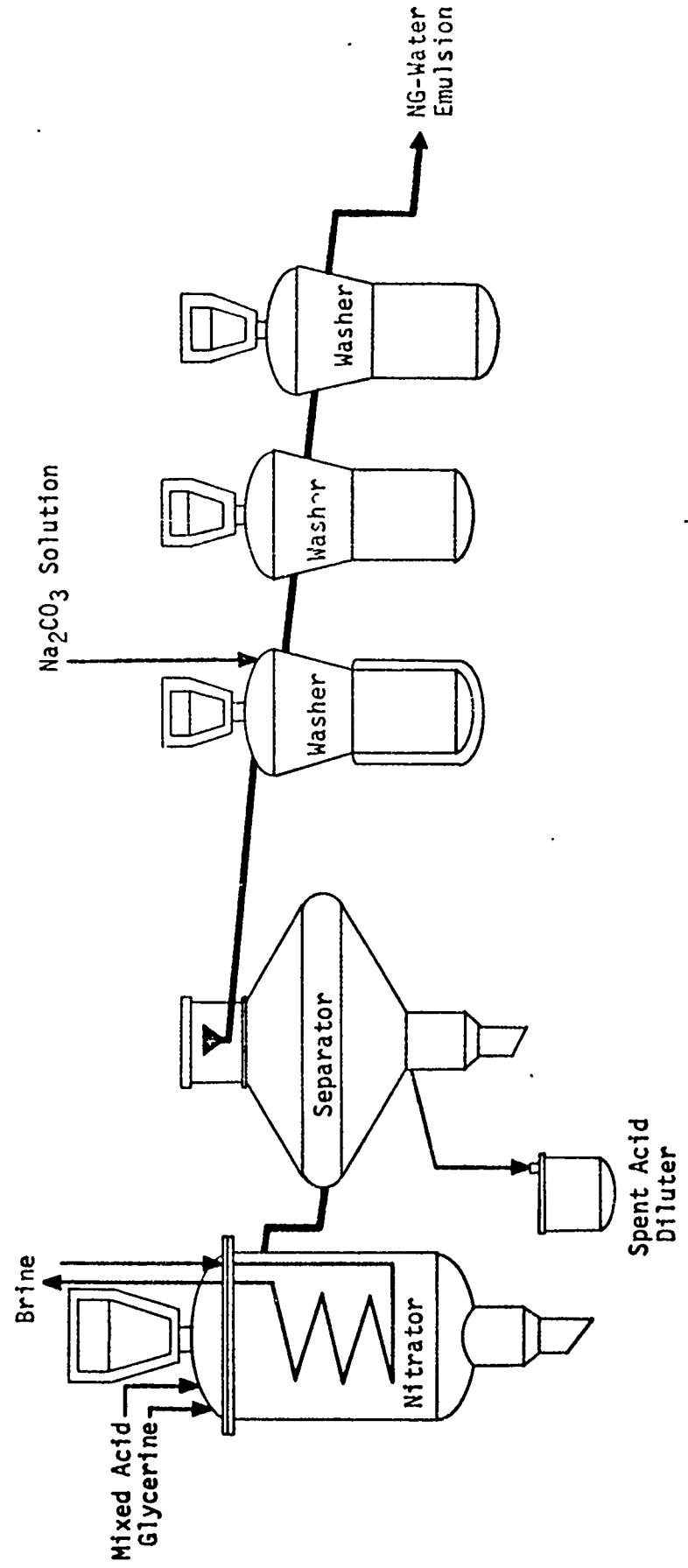
273. Air Pressure (psi) 8%

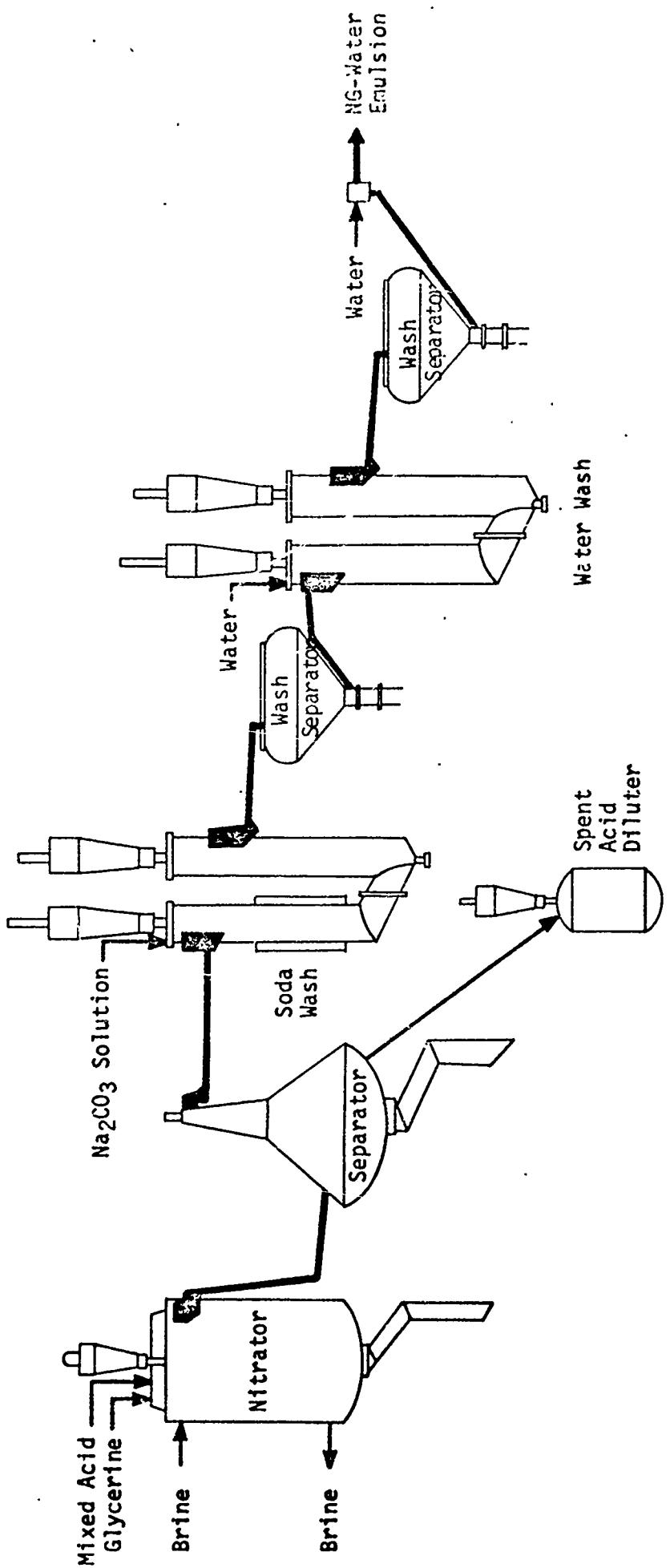
274. Refrigeration (tons) 8%

275. Process Water (gpm) 8%

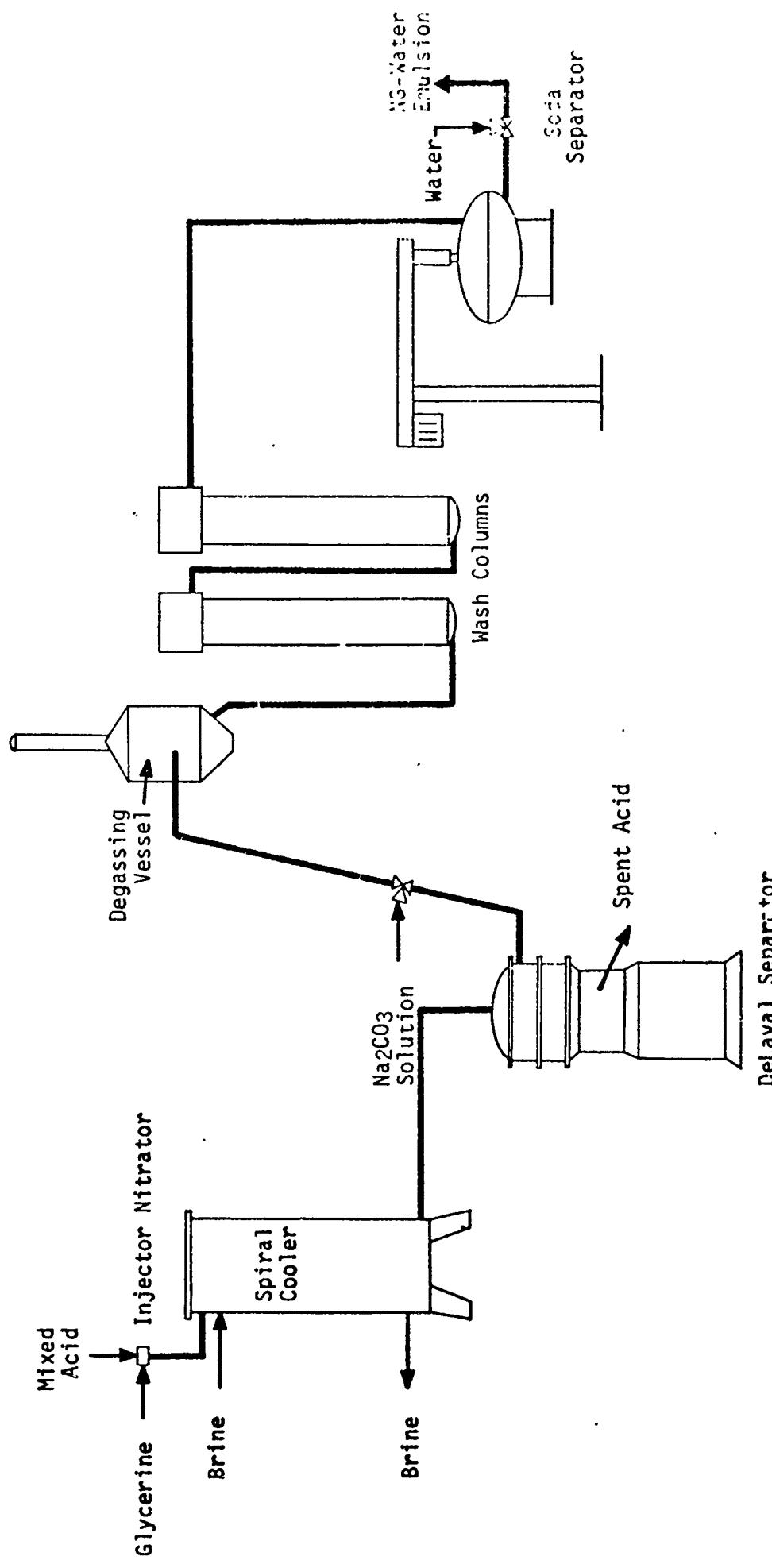
276. Process Steam

<u>G. Raw Material Requirements</u> <u>(per 100 lb of product)</u>	<u>Biaazzi</u>	<u>Hanspeter Moser</u>	<u>Nitro Nobel</u>
1. Glycerin (1b)	42.8	42.8	42.8
2. Mixed Acid [50-50] (1b)	208	208	208
3. Soda Ash	7	8.5	8.5
4. Semi Concentrated Mixed Acid (1b)	360	360	360
5. Spent Acid Byproduct (1b)	145	145	145





HANSPETER MOSER FLOW DIAGRAM



NITRO-NOBEL FLOW DIAGRAM

BADGER ARMY AMMUNITION PLANT  
OLIN CORPORATION  
ENERGY SYSTEMS DIVISION  
BARABOO, WISCONSIN

CONTINUOUS NITROGLYCERIN NITRATOR DESIGN EVALUATION  
USING A WEIGHED NUMERICAL METHOD

21 JULY 1970

## CONTINUOUS NITROGLYCERIN NITRATOR DESIGN EVALUATION

### USING A WEIGHED NUMERICAL METHOD

#### Method Description:

Each area of design comparison was considered from a standpoint of overall importance and given a weighed point value. The nitrator vendors were assigned a rank for each area of design comparison. A rank of 3 for the best design and a rank of 1 for the least desirable. Points were accumulated by multiplying the rank by the weighed point value for each area of design comparison. (Example: The nitrator type for Biaffi was assigned a rank of 2, times the weighed points of 20, equals an accumulation of 40 points.)

#### Discussion of Evaluation:

##### A. Nitrator

The capacity of the nitrator is considered very important. A smaller size means less nitroglycerin in process and lower retention time. Low reaction temperature and good cooling is also preferred. The time required to drown or empty the nitrator in case of a hazardous condition is also important.

##### B. Control of Nitrator

Considering methods of mixed acid feed, a control valve and flowmeter is preferred over a volumetric pump. The injector drawing glycerin to the nitrator only when mixed acid is fed is superior to other feed methods. The control valve is considered to have the more positive control of feed. Control of reaction temperature is best effected by control of the cooling media flow rate.

C. Separator

The type of separator is very important. A separator should not have any moving parts, be of small capacity with low retention periods. The total nitroglycerin content must be minimized, but more important, the amount of free nitroglycerin should be eliminated, if possible. Drowning time should be as quick as possible. Control of separation through control of spent acid exit flow is preferred.

D. Spent Acid Diluter

A large, stirred, cooled vessel is required.

E. Washing and Neutralizing

Countercurrent flow of emulsified nitroglycerin through soda water and then water is the preferred washing method. Several fast, low capacity washes are preferred over one large volume wash. Retention time and flow rates should be as low as possible. Minimum amounts of nitroglycerin are mandatory. Final wash pH control is required as well as nitroglycerin separation with the requirements listed above.

F. Utility Requirements

Minimum requirements are preferred.

G. Raw Material Requirements

Minimum requirements are preferred.

H. Calculation Summary

<u>Comparison</u>	<u>Weighed Points</u>	<u>Accumulated Points</u>		
		Biaazzi	Hanspeter Moser	Nitro Nobel
A. Nitrator	200	235	445	450
B. Control of Nitrator	100	220	200	260
C. Separator	200	410	490	390
D. Spent Acid Diluter	50	100	150	50
E. Washing & Neutralizing	200	370	530	385
F. Utility Requirements	100	230	220	180
G. Raw Material Requirements	<u>150</u>	<u>450</u>	<u>420</u>	<u>420</u>
TOTALS	1,000	2,115	2,455	2,135

I. Conclusion

- The Hanspeter Moser Continuous Nitrator Design is preferred based on the above evaluation.

# **SUPPLEMENTARY**

## **INFORMATION**



DEPARTMENT OF THE ARMY Mr. Fordham/rc/AUTOVON 825-3200  
BADGER ARMY AMMUNITION PLANT  
BARABOO, WISCONSIN 53913

SMCBA-CR

21 March 1985

SUBJECT: Distribution of Badger AAP Document

AD-A950784  
Defense Technical Information Center  
Defense Logistics Agency  
Cameron Station  
Alexandria, VA 22304-6145

1. Badger Army Ammunition Plant had a report done by its operating contractor, Olin Corporation, entitled "Design Comparison of Continuous Nitrators" dated 21 July 1970.
2. This report is a comparative evaluation of commercial processes and was never approved by Badger AAP for public release. A copy has come into our hands with your stamp on it, "DTIC Selected July 24, 1981", "~~AD~~-A950784", and "Approved for Public Release, Distribution Unlimited".
3. This report was never adopted nor its recommendation followed. This report was never intended for publication nor was it distributed outside of the U. S. Army Munitions Command and Omaha District Corps of Engineers. We did not submit it to your agency.
4. While we would still not consider this report releasable, it is obviously too late to stop public disclosure. In fact, the report has been used in advertising brochures to imply Army endorsement of their product.
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DAVID C. FORDHAM  
Commander's Representative